Fast Response Sensor for the Measurement of the Optical Properties and Carbon Content of Organic Aerosols

Interim Report, June 13 – July 30, 2001
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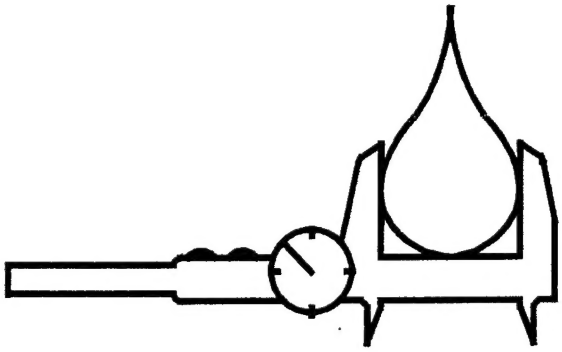
DROPLET MEASUREMENT TECHNOLOGIES



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Abstract

In the Phase I SBIR work under contract number N00244-00-P-2504, the feasibility of a protoype instrument, the aerosol vaporization spectrometer (AVS) was evaluated for the ability to classify particles by their incandescent signal. The objective is to provide real-time mass information on airborne black carbon particles. The instrument uses a diode pumped Nd:YAG laser at 1.06 μ wavelength to excite the particles. The scattering signal is monitored from all of the particles, and the black carbon particles absorb sufficient energy to incandesce, and this incandescence is measured by broadband and narrowband detectors. The work detailed in this report, conducted under the optional phase I funding is designed for an accelerated start on the Phase II developments. Two activities are taking place, the development of data acquisition software to collect and process the signals from the AVS, and optimization of the laser system for analysis of the black carbon particles.

1.0 Overview

This report summarizes activities on the project option entitled, "Fast Response Sensor for the Measurement of the Optical Properties and Carbon Content of Organic Aerosols" The initial work was conducted under the Navy contract N00244-00-P-2504 as an SBIR Phase I project. The goal is to evaluate a prototype instrument, the aerosol vaporization spectrometer (AVS), that uses a patented sensing technique to classify particles by their incandescent signals.

A schematic diagram of the instrument is given in Figure 1. Aerosol particles cross a 1.06 μ laser beam, and black carbon particles will absorb sufficient energy to be heated to the incandescence point. The scattering signal, broadband and narrow band incandescence signals are collected, and there is the option of measuring the infrared incandescence.

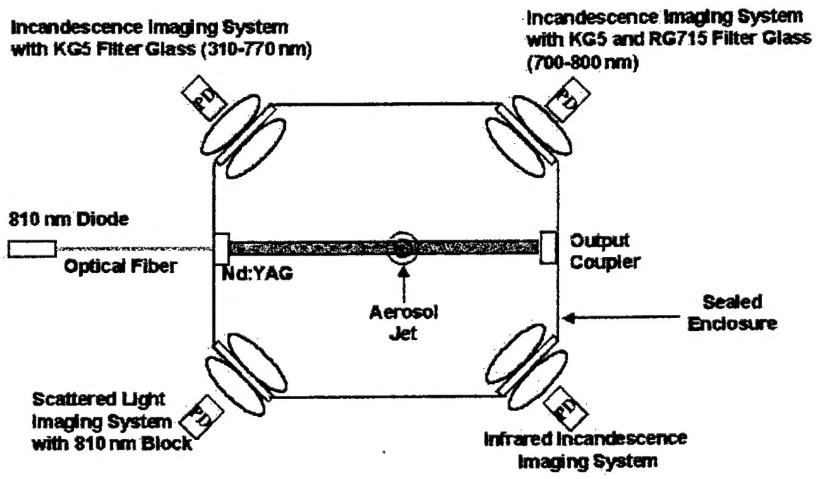

Figure 1
Diagram of the Aerosol Vaporization Spectrometer

2.0 Activities

Development of data acquisition and processing software for the AVS has been a major part of the activity for the Phase I option efforts. A part time programmer has been hired to work on the software. A data acquisition system utilizing a National Instruments 6110E high speed A/D board has been setup. The important aspect of this A/D board is the ability to sample four A/D converters simultaneously at up to 5 MHz speed. Since exact time synchronization of the

signals will be necessary for the data analysis, this A/D board will be an important component of the system.

The data acquisition software will operate in a triggered mode, using the scattering signal as the trigger. All other signals will be time referenced to this signal. The data acquisition will terminate when the scattering signal and the other incandescence signals have dropped to some preselected level.

Initially the data processing will be done in a two pass process, first acquisition of the data, and then reprocessing of the file to analyze the signals. The data processing will examine the signals for peak shape, peak width, height, area, and time to maximum from the initial trigger point. Since each particle will generate three signals, scattering, broadband incandescence and narrow band incandescence, a matrix of these relationships can be made to examine the response for each of the different types of aerosol particles. Once the optimum classification scheme has been established, the data processing will be implemented in realtime to provide immediate response on the aerosol composition.

The other activity, which is difficult to quantitate, is the cleaning and alignment of the 1.06 μ laser system for exciting the aerosol particles. A critical part of the system is the cleaning of the laser windows. The laser windows are protected by a sheath purge, but even in the presence of this purge aerosol particles can build up on the windows over time. This reduces the laser power output. Removal, cleaning and realignment of the laser has been a time consuming task, and considerable time has been spent in perfecting these techniques. This activity is important as proficiency in this area will reduce the downtime of the instrument, and ideas for improvement of the system are gained with this type of hands on activity.

Then next period of work will involve preliminary testing of the data system. Standard aerosols will be analyzed, and a matrix of the responses generated. A major consideration will be the time response of the system. The A/D board is rated at 5 MHz, and this level of speed will be necessary for proper analysis. Optimization of the computer and the software will be conducted.

Exhibit A

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13. ABSTRACT (Maximum 200 words)

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